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## Abstract

The present paper addresses coalition behavior both from a social psychological and a game theoretic perspective. Between seven and twelve players participated in a market game where one player was a monopolist. Five conditions allowed for analysis of the effects of the announcement of the payoff division, the announcement of the players' offers, and the availability of communication. The results were compared to bargaining theory (Komorita and Chertkoff, 1973), the weighted probability model (Komorita, 1974), pivotal power theory (Gamson, 1964), and to the game theoretic concepts of the core and the Shapley value (Shapley, 1953). The results indicated that the monopolist's payoffs increased over trials and approached the core, especially in the no message conditions. The message conditions supported the predictions of the weighted probability model and pivotal power theory. The results were also compared to earlier research on a similar three-person game; increasing the group size markedly increased the monopolist's payoffs. In addition, his position was so strong that his demands, especially in the no message conditions, almost strictly determined his payoffs.

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Two areas of inquiry have stressed the importance of coalition formation in conflict situations. N-person game theory has approached coalition behavior from a mathematical-economic point of view (e.g., von Neumann and Morgenstern, 1944) while social psychology has approached the problem from a sociological point of view (e.g., Caplow, 1956; Gamson, 1961). Only recently have the two approaches been considered together (e.g., Michener, and Sakurai, 1976). The present paper continues this effort to bridge the two areas by considering both social psychological theory and mathematical game theory as potential predictors of the bargaining outcomes within large groups.

A previous paper (Murnighan and Roth, 1976 ) considered the effects of communication and information availability in a three-person market game in which one player had a monopoly. Although the two weaker players could not attain any payoff by themselves, if they could coordinate their actions they could block the attainment of any payoffs by the monopolist. The results indicated that the monopolist's payoffs were significantly reduced when the players were given the opportunity to send messages. In addition, the announcement of the payoff division resulting from each of the agreements also tended to reduce the monopolist's payoffs, while the announcement

of which offers were accepted and rejected by each of the players tended to increase the payoffs of the monopolist.

The results were also compared to several game theoretic solution concepts. In particular, the data were compared to the core (cf., Luce and Raiffa, 1957), where the monopolist would receive the entire payoff (100 points). The mean payoffs in the six different communication/information availability conditions, however, ranged from 56 to 77. Even though the results did not reach the core, the monopolist's payoffs increased as the rules of the game restricted the availability of information and/or communication. Thus, the notion that the core results from competitive play of the game was not completely unsupported.

The present study attempted to further delineate the conditions which would be conducive to greater competition among the weaker players and, therefore, increased payoffs for the monopolist. The major change between the present and the previous study was in the number of weak players. While the previous study considered a situation with the smallest possible number of weak players (i.e., two), the present study considered a situation where there were anywhere from 6 to 11 weak players.

Manipulation of group size to increase the competitiveness of the game (at least for games with one strong player) is consistant with both social psychological theory (e.g., Komorita, 1974) and game theoretic results in the economic literature. In a number of contexts, it has been shown that as the number of players in a market game becomes large, the set of outcomes in the core become identified with the competitive equilibria of the market

(cf. Debreu and Scarf, 1963; Aumann, 1964). This supports the view that outcomes in the core result from competitive play of the game.

A related point of view is that the game itself becomes more competitive as the number of players increases. Indeed, the Shapley value of a market with many players becomes identified with the competitive equilibria and the core (cf. Aumann, 1975; Aumann and Shapley, 1971; Champsaur, 1975; Shapley, 1953). It has been recently demonstrated (cf. Roth, 1976) that the Shapley value is a risk-neutral cardinal utility function which reflects a player's preference for playing a given position in the game. In other words, the Shapley value represents the expected outcome for a player, before the game is played. Thus, the identification of the Shapley value with the competitive outcomes in a game suggests that the a-priori evaluation of the game is that it will result in a competitive outcome.

Among the social psychological theories, Komorita's (1974) Weighted Probability model assumes that small coalitions (i.e., those with few members) are more likely to form than large coalitions, and that a player who has the ability to form powerful small coalitions will receive a larger proportion of the payoff than players who must depend on many other players to form a powerful coalition. The model's predictions for the previous study were quite good; a monopolist opposed by 2 weaker players was predicted to receive 67% of the payoff. The results, over all conditions, indicated that the monopolist received about 65% of the payoffs. For the present study, the model predicts that the strong player's payoffs will range from 89 to 92% as the number of weak players increases from 8 to 11.

Another social psychological theory, Komorita and Chertkoff's (1973) Bargaining theory, makes a different set of predictions:[1] given one monopolist and at least two weak players, Bargaining theory predicts that the monopolist should receive 75% of the payoffs, regardless of the number of weaker players. The predictions for the previous study were appropriate in two of the six conditions, and those two conditions were predicted to be among the most competitive. Because the theory assumes competitive motivations on the part of the players, the data supported its predictions. The present study, however, investigates an even more competitive situation. Because Bargaining theory's prediction does not change with greater numbers of weak players, this study provides a strong test of its predictions and a strong test of its general applicability.

The final theory which the present study addresses has roots in both social psychology and n-person game theory. While Pivotal Power theory is based on the Shapley value (Shapley, 1953), it was first mentioned by Gamson (1964). A player's pivotal power is determined by his ability to bring pivotal resources to a coalition. Pivotal Power theory predicts that coalitions which minimize pivotal power will form, and that each player's payoff will be proportional to his pivotal power. The theory has fared poorly in most social psychological research (e.g., Murnighan, Komorita, and Szwajkowski, Note 2). However, in the present study, even though its predictions are based on an entirely different set of assumptions, Pivotal Power theory makes the same predictions as the Weighted Probability model. In addition, not only does the data presented here have import for both the

social psychological and the mathematical approaches to n-person bargaining, the conflict situation which was studied also tends to bridge the gap that has separated the two theoretical areas.

## Method

Subjects. The participants in this study were 264 male undergraduates, predominantly juniors, enrolled in an introductory organizational behavior course at a large midwestern university. Students completed part of a course requirement by participating.

Design. Three factors were manipulated: (1) secret or announced payoff divisions; (2) the opportunity to send messages vs. no such opportunity; and (3) secret or announced offers (including the announcement of acceptances and rejections of the offers). Although a complete factorial design would have resulted in eight conditions, three of the eight conditions were not conducted; all three included no announcement of the payoff division when either messages were available and/or when the offers, acceptances, and rejections were announced.[2] The five remaining conditions, then, were: (1) secret payoff division-no-messages-secret offers; (2) announced payoff division-no messages-secret offers; (3) announced payoff division-no messages-announced offers; (4) announced payoff division-messages available-secret offers; and (5) announced payoff division-messages available-announced offers.

The design can be broken down into a 2 x 2 (messages and offers) design, with an additional condition which allows for a test of the effects of not announcing the payoff division.

The Game. The participants were put in a situation very similar to the earlier study. The game was presented as a market consisting of 7 to 12 players, depending on the number of participants in each session (see Table 1). For each trial in the game, player A owned a right shoe while

Insert Table 1 about here

each of the other players owned a left shoe. Single shoes had no value, but a pair of shoes (consisting of one right shoe and one left shoe) could be sold for 100 points. Thus, no player acting alone could earn any income from the market, but any coalition of players which could assemble a pair of shoes could earn 100 points. Player A thus controlled a monopoly on right shoes. The game can be modeled in characteristic function form where $N = (A,B,C,\ldots,L)$, $v(A) = v(X) = v(XX) = \ldots = 0$, and $v(AX) = v(AXX) = \ldots = 100$, where (1) X indicates one of the players in positions B through L; (2) XX indicates two players in the positions B through L, and so on, and (3) v indicates the value or payoff which the coalition identified inside the parentheses could obtain.

The core of this game consists of the outcome at which player A receives 100 points, and the remaining players each receive 0 points. This outcome is also the unique competitive allocation of the game.

The Shapley value of the game played by no players and the prediction of the Weighted Probability model give player A a payoff of $100 - \frac{100}{n}$. Note that as the number n increases, the predictions approach the core.

Procedure. The participants were given written instructions which were also read aloud by the experimenter. The instructions presented the game (described earlier) and the following (summarized) information:

"Your task is to bargain among yourselves to determine who will sell their shoes and how the sellers will divide their payoff. We will repeat this procedure several times, with each player assuming the same position each time." The players were then instructed in the mechanics of the experiment. After reading these instructions, the experimenter went over several examples to insure that each of the participants understood the rules and mechanics of the game. Only after all the players expressed understanding of the entire set of instructions did the procedure continue. This instruction phase typically consumed 30 minutes.

The players were seated in three adjoining rooms. No verbal communication was permitted. All players were separated from one another by opaque partitions so that they could not determine the identity of any of the players in any of the positions. The monopolist was in a small room by himself. Each of the players' positions was randomly determined.

Each player filled out offer slips which consisted of the choice of a bargaining partner and a proposed payoff division totalling 100 points. The experimenter collected each of the players' offers. After all the players had submitted their offers, the experimenter recorded the trial number and passed the offers to the appropriate players. Upon receiving one or more offer slips, each player could accept at most one of the offers. An agreement was defined to be reached when an offer was accepted. However, when more than one offer was accepted, each player was bound to the offer he had made; this means that if a player made an offer which was accepted, he was held to that offer, even if he had accepted an offer for

another agreement. The experimenter carefully explained to the players that if a left shoe player received an offer from A and accepted it, he would be included in the winning coalition. In addition, A could protect himself from "mutiny" by accepting a two-person offer from any one of the left shoe players. If his own offer were rejected, his choice of the left shoe players' offers would determine the agreement. In cases where two players accepted each other's offers but the payoff divisions were different, the average of the two payoff divisions was recorded. For offers which included more than one other player, all players receiving the offer were required to accept it if that coalition were to form. This procedure (originally used by Komorita and Meek, Note 1) was repeated for seven completed trials or until time ran out.

In the secret payoff division conditions, the positions of the players included in the agreements were announced. In the announced payoff division conditions, the points won by each of the coalition members were also announced. When this division was announced, there were often vocal exclamations by some of the players. The experimenter's instruction to formulate the next offer usually quieted any commotion. In addition, none of the players seemed to communicate nothing other than surprise in these situations.

In the "offers announced" conditions, the offers, acceptances, and rejections of the monopolist were announced over an intercom system. The offers of the left shoe players, if directed only to the monopolist, were not announced individually; rather, the range of offers by the left shoe players to the monopolist were announced. All offers which included the monopolist and more than one of the other players were announced as well.

In addition, the individual responses of the left shoe players to the monopolist's offers (i.e., their acceptances and rejections) were announced.

In the groups where messages were allowed, the players were allowed to send any communications they wished. The monopolist could send a message to any of the left shoe players individually. The left shoe players, however, could send messages either to the monopolist or to all of the other left shoe players. To simplify procedures, individual communications between left shoe players were not allowed. When a message was sent to all the left shoe players, it was read over the intercom to the two rooms which housed the left shoe players. In order to insure that the monopolist did not hear the messages of the left shoe players, low volume white noise was broadcast into his room. (All of the monopolists in this condition reported that they had not heard any of the announcements which the experimenter read over the intercom at the start of each bargaining session.) In the conditions where payoffs, offers, acceptances, or rejections were announced, the experimenter personally delivered this information to the monopolist.

## Results

Although 26 groups participated in the study, the data from three of the groups (one each in the second, fourth, and fifth conditions) were not included in the analysis because they did not complete 7 trials. In one of the groups the monopolist made several proposals to more than one of the left shoe players which were not accepted. This resulted in several rounds which did not result in agreements. The other two groups can be characterized by the large number of messages which were sent in each group. In addition, the monopolist in one group expressed confusion with

the procedure and tended to be very slow in making his offers, while the members of the other group sent a large number of "all included" proposals. In both cases, time expired prior to the fourth trial.

The data from these three groups was insufficient for normal statistical analysis. However, the agreements which were reached were quite similar to those obtained in the other sessions.

The remaining data were analyzed with the monopolist as the central focus. In particular, the major dependent variables in the analyses included the monopolist's payoffs and demands, and the highest and lowest offers he received. Due to the fact that the left shoe players were never able to form an effective blocking coalition which substantially reduced the monopolist's payoffs, the only variable in the analyses which focused on the left shoe players was the number of times they proposed an agreement which included all of the players in the game.

The analysis of the dependent variables associated primarily with the monopolist took two directions. The first analyzed the effects of information on his payoffs, demands, etc. In particular, these analyses used the three "no message" conditions to test the effects of increasing information on the bargaining processes and outcomes; separate 3 x 7 (information by trials) analyses of variance were conducted for the four dependent variables mentioned above.

The second direction taken by the analyses focused on the impact of the two message conditions in conjunction with the two offer conditions (and the seven trials). Separate 2 x 2 x 7 (messages by offers by trials) analyses of variance were conducted for each of the dependent variables. In each case, the trials variable was restricted to trials where agreements were reached; this avoids missing payoff data and disparate levels of the trials variable.

The distributions of the monopolist's payoffs, demands, and highest offers were negatively skewed in each of the conditions. Each of these variables, then, was transformed prior to analysis using the appropriate log transformation[3] (Winer, 1962). In reporting the means for each of the analyses, the means of the transformed scores were retransformed. This second transformation results in more appropriate estimates of the central tendencies of the distributions involved. In each of the tables and figures, then, the means have all been retransformed (adjusted).

Main effects for trials were significant in each of the analyses for the monopolist's payoffs, demands, highest and lowest offers. Table 2 displays the adjusted means for each of the variables (the means for lowest offers were not adjusted) summed over all five conditions, and clearly

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Insert Table 2 about here

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shows a continuous increase in payoffs, demands, and highest offers over trials, and a continuous decrease in lowest offers over trials. This same effect was found in each of the subsequent analyses, indicating a consistently dynamic bargaining process in each of the conditions.

These findings are damaging to Bargaining theory, the Weighted Probability model, and Pivotal Power theory. None of these models predicts such an increase in the monopolist's payoffs as the trials progress. The findings do support the notion that the bargaining was moving toward the competitive equilibrium, the core. As the trials progressed, the monopolist's payoffs continuously approached the entire 100 points.

In the analysis of the impact of information, the only effect to reach significance were the trials main effects, mentioned above. For the strong player's payoffs, demands, highest offers, and lowest offers, the information main effects and interactions revealed no significant findings. In addition, a separate test of the effects of the announcement of the payoffs resulted only in a significant trials main effect.

The analysis which focused on the impact of message availability (paired with the different offer conditions) did result in several significant effects. Table 3 displays the adjusted means, the F-ratios and the p-values for the

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Insert Table 3 about here

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significant messages main effects for the monopolist's payoffs, demands, and highest offers. In each case, the no message conditions favored the monopolist. In addition to these main effects, there were significant interactions between messages and trials for the strong player's payoffs and highest offers: $F\ (6,72) = 2.24$, $p < .05$ and $F\ (6,72) = 3.00$, $p < .05$, respectively. Table 4 depicts both interactions. Post hoc tests using the Newman-Kuels procedure

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Insert Table 4 about here

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(Winer, 1962) indicated that, for highest offers, there were no significant differences in the messages conditions, but that the highest offers for the first trial were significantly less than the highest offers for the last trial in the no message conditions. For A's payoffs, there were again no differences across trials within the messages conditions; when there were

no messages, however, A's payoff on the first trial was significantly less than his payoffs on the last three trials.

The results cited above are not strictly independent from one another. The monopolist's payoffs, demands, and highest offers are correlated with one another to a high degree. For instance, it is not surprising that A, who holds a position of considerable power, could make increasingly high demands, and in most cases expect to continue receiving high payoffs. His payoffs and demands, over all conditions, were highly correlated: $4(161) = .85$, $p < .0001$. The correlations within each of the conditions were consistently high, especially in the later trials. Although A's highest offers were also highly correlated with his payoffs [$r(161) = .60$, $p < .0001$], the relationship is not quite as strong. To get a clearer picture of the impact of the independent variables, a multivariate analysis of variance was conducted with messages, offers, and trials (2 x 2 x 7) as independent variables and A's payoffs, demands, and highest offers as dependent variables. As before, the trials main effect was significant: $F$ (18, 198) = 2.27, $p < .001$. The only other effect which approached significance was the messages main effect: $F$ (3, 10) = 2.70, $p < .10$. The step-down $F$-ratio for the effects of A's payoffs over the effects of A's demands, was less than 1.00, indicating the dependence of the monopolist's payoffs on his demands rather than on the high offers he received. The relationship between his demands and payoffs is so strong that one can almost conclude that he could obtain any payoff he wished.

The proportions of "all included" proposals sent by the left shoe players were transformed[4] prior to analysis (Winer, 1962). Analyses of variance resulted in significant trials and messages main effects:

$F$ (6, 108) = 7.25, $p < .00001$ and $F$ (1, 12) = 5.94, $p < .05$, respectively. No other main effects and no interactions were significant. For each of the trials, there were 212 opportunities for left shoe players to propose an "all included" coalition. The actual frequencies of "all included" proposals for the 7 trials were 1, 6, 17, 20, 32, 37, and 32. The increase from the first through the fifth trials is fairly dramatic. For the messages effect, there were 29 "all included" proposals in 511 opportunities in the no message groups, and 99 "all included" proposals in 504 opportunities in the messages groups. These results indicate the possiblity of a causal chain, starting at message availability and leading to increased "all included" proposals. This may lead to a damping effect on A's payoffs. The present data support the first link in this chain. Further research is necessary to support the second.

An analysis of the number of "all included" offers by the left shoe players investigated possible relationships with the monopolists' outcomes. There were no significant correlations between the number of "all included" proposals and A's payoffs or demands, but the number of "all included" proposals were negatively correlated with the highest offers A was receiving: $r = -.19$, $p < .01$. Again, this finding indicates the effects which the monopolist's demands had on his outcomes. Even though the highest offers he received were lower when there were many "all included" proposals, his payoffs and demands were not significantly affected.

The final analysis concerned the effects which the unequal numbers of players in the groups may have had on the results. Correlational analysis between the number of players and the dependent variables revealed no significant relationships.

To summarize the results, the findings indicated that: (1) The monopolist's payoffs and demands, the highest offers he received, and the number of "all included" proposals made by the left shoe players all increased over trials. (2) Announcement of the offers had no significant effect. (3) The availability of messages reduced the monopolist's payoffs, demands, and highest offers. In addition, when messages were not available, the monopolist's payoffs and the highest offers he received increased over trials; when messages were available, there was only a minor, insignificant increase over trials. (4) There was a strong positive relationship between the monopolist's demands and his payoffs. A similar, but less strong relationship was found between his payoffs and the highest offers he received. (5) More "all included" proposals were made by the left shoe players in the message conditions. The number of "all included" proposals was negatively correlated with the highest offers received by the monopolist. (6) The number of players was not significantly correlated with the dependent variables.

## Discussion

Comparisons between the four theoretical formulations and the observed data are quite striking. Whereas, in the previous study, the monopolists' payoffs tended to support the social psychological theories, the results in the present study move very close to the core.
It is somewhat incongruous that, even though the data revealed increases in the monopolist's payoffs over trials, the Bargaining theory (which normally predicts just such a change) makes a static prediction which becomes more and more inaccurate as the trials progress. The predictions of the Weighted Probability model and Pivotal Power theory approximate

the monopolist's payoffs, especially in the conditions where messages were allowed. The increasing nature of the monopolists payoffs, however, is at variance with the two models' predictions. Overall, the game theoretic concept of the core seems to be the most appropriate depiction of the actual progression of the monopolist's payoffs, especially in the no message conditions. Indeed, the magnitude of the results is quite striking. What is even more striking than the means of the monopolist's payoff distributions is the fact that in 52 of the 105 no message trials, he received 99 of the 100 points, or more. Player A held a very powerful position, and the strong positive relationship between his demands and payoffs further testifies to his power.

While the magnitude of the present data differs markedly from that of the previous study, the effects caused by the different conditions were quite similar. In this particular game, the competition among ten weaker players was sufficient to drive the results to the core. In both studies the change in conditions caused the outcomes to shift along one parameter curve, of the sort described by solutions (von Neumann-Morgenstern, 1944) or subsolutions (Roth, 1976b) to the cooperative game. Indeed, the fact that both this study and the previous study (Murnighan and Roth, 1976), which used a decidedly different situation (only three players), found similar results leads to greater confidence in their validity.

The opportunity to send messages resulted in lower payoffs, demands, and high offers for the monopolist compared to the no message conditions. As before, the number of "all included" proposals increased when messages were allowed. It is interesting to note, however, that "all included" offers seem to act as messages when messages are not allowed. As soon

as one individual sent an "all included" offer, everyone had the opportunity to see that A's payoffs might be reduced. This differed from the earlier study, where "all included" offers often were disregarded by the other weak player. In the present study, the probability that some other left shoe player might choose the same strategy on the next trial increased, if only because there were more players.

In addition, in the two groups where the monopolist initiated the "all included" proposals, "all included" coalitions were not successful. Instead, the monopolists in these two groups might be characterized as "frustrated benevolents." Of the 15 left shoe players who received these offers (9 in one group, 6 in the other), only 5 accepted. It seems that the left shoe players were either unwilling to pursue a "cooperative" strategy or were unwilling to trust the other players to also agree. Given that all but one of the weak players responded with proposals including only A and themselves on the subsequent trials, the first alternative seems to be correct. A norm may be prevalent, at least in the early trials, to attempt to establish two-person agreements including yourself and the strong player and no one else. This hypothesis, however, should be tested in future research.

The messages in this study also seemed to fulfill a different function from the messages in the three-person study. Whereas the messages in the previous study were almost exclusively task-related (for instance, "Let's both offer and accept only 50-50 agreements"), the messages in the present study fulfilled additional functions. While they often urged the other players to adopt a unified front, after several attempts to block the monopolist had failed, many of the messages seemed to be sent simply to relieve

tension. Messages like "I'm getting out of the shoe business. It's apparent that I don't have but one foot to stand on." were quite common in the later stages of the game.

In addition, messages were often used to double cross the other left shoe players. On most occasions when there was a concerted effort to hold to "all included" proposals, at least one of the left shoe players would send a message to A to inform him of this development, in the hope that he might negotiate an individually rewarding agreement.

The data from this study lead to questions concerning the generalizability of social psychological theory in complex n-person bargaining situations. While earlier reports (cf., Komorita, 1974) tended to support both Bargaining Theory and the Weighted Probability model, more recent results (Murnighan, Komorita, and Szwajkowski, Note 2) are not so clear-cut. The present study adds to this confusion by considering yet another variable, communication opportunities, in a game which includes a monopolist. Although a situation where one person has veto power is at variance with Gamson's (1961) original definition of a "full-fledged coalition situation," the bargaining processes in such a situation are not unimportant. As the authors argued in a previous paper (Murnighan and Roth, 1976), a taxonomy of games which takes into consideration both psychological and mathematical variables is sorely needed, for the generalizability of models in both game theory and in social psychology can be questioned. The present study certainly adds more weight to this argument.

## Conclusions

The present study obtained findings which indicated that a single monopolist in a large group can and will obtain large payoffs from the

other group members. In particular, the extreme magnitude of his payoffs and the fact that the monopolist's payoffs increase over time compare very favorably with the game theoretic notion of the core, while three social psychological models, the Weighted Probability model (Komorita, 1974), Bargaining theory (Komorita and Chertkoff, 1973), and Pivotal Power theory (Gamson, 1964), do not make such accurate predictions. In addition, the results indicate that the monopolist received significantly lower payoffs when the players had the opportunity to send messages to one another. When compared to a previous study which investigated three-person groups, the present study indicates that increasing the group size increased both the power and the payoffs of the strong player, and that the dynamics of the communication process changed through the use of several different types of messages.

## Reference Notes

1. Komorita, S. S., and Meek. Some preliminary tests of a bargaining theory of coalition formation. Unpublished manuscript, Indiana University, 1973.

2. Murnighan, J.K., Komorita, S. S., and Szwajkowski, E. The effects of reference groups on bargaining in coalition situations. Working paper #313, College of Commerce and Business Administration, University of Illinois at Urbana-Champaign.

References

Aumann, R. J. Markets with a continuum of traders. Econometrica, 1964, 32, 39-50.

Aumann, R. J. Values of markets with a continuum of traders. Econometrica, 1975, 23, 611-646.

Aumann, R. J., and Shapley, L. S. Values of non-atomic games. Princeton, NJ: Princeton University Press, 1971.

Caplow, T. A theory of coalitions in the triad. American Sociological Review, 1956, 21, 489-493.

Champsaur, P. Cooperation versus competition. Journal of Economic Theory, 1975, 11, 394-417.

Debreu, G., and Scarf, H. A limit theorem on the core of an economy. International Economic Review, 1963, 4, 235-246.

Gamson, W. A theory of coalition formation. American Sociological Review, 1961, 26, 373-382.

Gamson, W. Experimental studies of coalition formation. In L. Berkowitz (Ed.), Advances in experimental social psychology, Vol. 1. New York: Academic Press, 1964.

Komorita, S. S. A weighted probability model of coalition formation. Psychological Review, 1974, 81, 242-256.

Komorita, S. S., and Chertkoff, J. M. A bargaining theory of coalition formation. Psychological Review, 1973, 80, 149-162.

Luce, R. D., and Raiffa, H. Games and decisions. New York: John Wiley, 1957.

Michener, H. A. and Sakurai, M. M. A research note on the predictive adequacy of the kernel. Journal of Conflict Resolution, 1976, 20, 129-142.

Murnighan, J. K., and Roth, A. E. The effects of communication and information availability in an experimental study of three-person game. Management Science, 1976, in press.

Roth, A. E. The Shapley value as a von Neumann Morgenstern utility. Econometrica, 1976a, in press.

Roth, A. E. Subsolutions and the supercore of cooperative games. Mathematics of Operations Research, 1976b, 1, 43-49.

Shapley, L. S. A value for n-person games. Annals of Mathematical Studies, 1953, 24, 307-317.

von Neumann, J., and Morgenstern, O. Theory of games and economic behavior. Princeton, N.J.: Princeton University Press, 1944.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

## Footnotes

1. Bargaining Theory's predictions uses the distribution of resources (usually votes) among the players to determine each bargainer's expected maximum outcome. While the present study did not use a resource distribution, predictions can be derived if one assumes that the monopolist's expected maximum outcome is 100 points.

2. Keeping the payoff division secret, for instance, is impossible when every player's offers, acceptances, and rejections are announced. In addition, making messages available without announcing the payoff division may have confounded the information exchange between conditions.

3. For the positively skewed dependent variable, $x' = \ln(x)$.
   For the negatively skewed dependent variables, $x' = \ln(101 - x)$.

4. The scores used in the analysis were

$$2 \arcsin\sqrt{\frac{\text{number of "all included" proposals}}{\text{number of opportunities for "all included" proposals}}}$$

Table 1. The Size of the Groups in Each of the Conditions.

| | Payoff Division Secret | Payoff Division Announced | Offers Announced |
|---|---|---|---|
| No Messages | 7, 10, 10, 11, 11, 11, 12, 12 | 10, 11, 12, 12 | 7, 9, 9, 11 |
| Messages Available | --- | 9, 10, 11, 11 | 8, 10, 11, 11 |

Table 2. Adjusted Mean Payoffs, Demands, Highest Offers, and Lowest Offers for the Trials Main Effects over All Five Conditions, with Corresponding F-rations and p-values.

| | TRIALS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | F* | p< |
| Payoffs | 85.6 | 90.7 | 93.4 | 95.3 | 96.0 | 96.0 | 95.5 | 7.85 | .00001 |
| Demands | 89.3 | 92.1 | 94.8 | 95.8 | 96.0 | 96.7 | 96.5 | 5.46 | .0001 |
| Highest Offer | 95.5 | 96.5 | 97.8 | 97.9 | 98.0 | 98.2 | 99.0 | 5.47 | .0001 |
| Lowest† Offer | 34.3 | 27.8 | 35.7 | 22.6 | 26.4 | 16.8 | 15.8 | 3.33 | .005 |

† These means are not adjusted. The underlying distribution for this variable was not significantly different from a normal distribution.

*df = 6, 108

Table 3. The Adjusted Means, F-ratios, and p-values for the Significant Main Effects for Messages

| | No Messages | Messages | F* | p< |
|---|---|---|---|---|
| Payoffs | 96.3 | 89.8 | 5.48 | .05 |
| Demands | 95.9 | 89.0 | 5.96 | .05 |
| Highest Offer | 98.63 | 94.53 | 8.30 | .05 |

*df = 1, 12

Table 4. The Adjusted Means for the Significant Messages by Trials Interactions for the Strong Player's Highest Offers and Payoffs.

| Dependent Variable | Condition | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Highest Offer | No Messages | $95.0_{bc}$ | $96.1_{abc}$ | $98.9_{abc}$ | $99.2_{ab}$ | $99.3_{ab}$ | $99.3_{ab}$ | $99.7_{a}$ |
| | Messages | $93.4_{c}$ | $95.1_{bc}$ | $93.8_{bc}$ | $93.6_{c}$ | $94.3_{bc}$ | $94.6_{bc}$ | $96.5_{abc}$ |
| Payoffs | No Messages | $85.1_{cd}$ | $91.4_{abcd}$ | $95.9_{abcd}$ | $97.6_{abc}$ | $98.3_{ab}$ | $98.1_{ab}$ | $98.6_{a}$ |
| | Messages | $82.0_{d}$ | $88.6_{bcd}$ | $90.9_{abcd}$ | $98.9_{abcd}$ | $91.2_{abcd}$ | $92.4_{abcd}$ | $91.1_{abcd}$ |

Note: Cells with common subscripts, within the set for each dependent variable, are not significantly different from one another at the .05 level using the Newman-Kuels procedure.